

# The theory of transformation pressure - a new perspective on growth and economic policy<sup>1</sup>

Lennart Erixon\*

Department of Economics, Stockholm University, 106 91 Stockholm, Sweden

---

## Abstract

The theory of transformation pressure offers a uniquely Swedish perspective on the "productivity slowdown" of the 1970s and 1980s. One example of this theory can be found in an influential argument from the early 1990s which states that devaluations of the Swedish currency lessened the external pressure on manufacturing and led to a delay in structural change and rationalisations. The theory generalises the idea that productivity growth in firms is stimulated by intense competition, cost pressures and low or qualified demand. The main challenge faced by such a theory is to explain why it seems that an immediate threat is needed to get a productive response from firms. The theory presented here assumes either genuine uncertainty, irrational behaviour or that firms become more creative when they are put under real pressure. Productivity growth is not always promoted by tight external circumstances. Growth may be maximised if pressure in each period is moderate or if periods with strong pressure are followed by periods of financial and technical consolidation.

JEL classification: D24; D81; L16; L21; N64; O31

Keywords: Transformation Pressure; Competition; X-inefficiencies; Innovations; Productivity; Growth; Rationality; Uncertainty; R&D investments

---

\* Corresponding author. Tel.: + 46 8 162136; fax: +46 8 159482; e-mail: lex@ne.su.se.

<sup>1</sup> Previous versions of the paper have been presented at a workshop on industrial and technological development arranged by the Royal Institute of Technology in Stockholm November 26-28, at a symposium on bankruptcies arranged by Entrepreneurship and Small Business Research Institute in Stockholm January 28-29 1998, on a seminar at the Department of Economics, Stockholm University, March 19 1998, and at a conference arranged by the Swedish National Committee for the History of Technology in Stockholm May 11-12 1998. The research is funded by Swedish Council for Planning and Coordination of Research (FRN).

## 1. Introduction

A theory of transformation pressure is a unique Swedish element of the debate about the slowdown in economic growth during the 1970s and the 1980s. A government expert commission emphasised in the early 1990s that productivity growth was low in Sweden because of a weak transformation pressure. Above all, repeated devaluations of the Swedish crown (SEK) had delayed rationalisations and structural change in the exposed sector (Produktivitetsdelegationen, 1992). Swedish politicians unequivocally accepted this theory, even those who had been responsible for the devaluation policy in the 1980s. They used the theory in the early 1990s as an argument for hard-currency policies but also for deregulation, EU integration and a more rigorous anti-trust legislation. Ironically, the theory of transformation pressure was later accused of having contributed to the sharp decline in Swedish GDP growth 1991-1993. A resistance to pay-roll tax reductions and floating exchange rates until late 1992 was partly based on a conviction among politicians and influential economists that transformation pressure must be kept high to raise productivity growth.

The formulation of a theory of transformation pressure was facilitated by a unique Swedish tradition at the intersection between macroeconomics and industrial economics with Johan Åkerman, Erik Dahmén (a pupil to Åkerman) and Ingvar Svennilson as outstanding figures (see Åkerman, 1960, Dahmén, 1970 and Svennilson, 1954). In fact, the concept transformation pressure was first used by Dahmén to distinguish prime driving forces in Swedish industrialisation. The Swedish economists also integrated business cycle theory and growth theory. The focusing on a relationship between exchange-rate policies and productivity growth in Sweden in the early 1990s was clearly in line with a domestic tradition in economics.

There are several reasons why transformation pressure or similar concepts have played a peripheral role in growth economics during the latest decades. First, a discussion of a relationship between exchange-rate policies, or other stabilisation-

policy measures, on the one hand and growth on the other hand is made more difficult by a proposition in neo-classical (and also in some neo-Keynesian) macroeconomic models that demand does not matter for output in the long run. But I will insist on that "disequilibrium" states caused by separate stabilisation-policy measures may last for a long time due to rigidities on commodity, labour or financial markets. For instance, it took almost a decade before the profits from Swedish devaluations in the early 1980s were eliminated by increases in nominal wages (Lindbeck, 1993, pp. 81-82).

Second, in Keynesian models where stabilisation policies have an impact on long run output, there is no place for a theory of transformation pressure. In the latter theory, investments may be stimulated by reductions of profitability. A basic assumption in Keynesian models, as in other influential business-cycle theories, is that investments will be lowered by a reduction in expected profitability. Furthermore, in both American (neo-)Keynesian and European (post-)Keynesian models, macroeconomic imbalances are reinforced by the fact that the relationships between current demand, profits and investments are positive. The positive relationships emerge through the accelerator, the existence of backward-looking expectations or the desire of self-finance (Kalecki, 1965, Harcourt and Kenyon, 1976, Greenwald and Stiglitz, 1993). Besides, expansionary economic policies (or tight demand conditions in general) will encourage not only investments but also total factor productivity in Keynesian models assuming static scale advantages or investments embodying new technologies (dynamic scale advantages).

Third, the role of transformation pressure has been obscured by another proposition in macroeconomics - even if imbalances can be lengthy, because of market failures or destabilising expectations, it is output levels rather than growth that are concerned. A possible (post-) Keynesian objection is that the relationships between product demand and supply above may, if market adjustments are slow, give rise to cumulative processes of growth (Kalecki, 1965, Harrod, 1970, Steindl, 1979). However, Keynesians only confirm a theory that stabilisation policies (including exchange-rate policies) matter for growth, not the specific theory of transformation pressure. According to Keynesian thinking, growth will be stimulated, not impeded, by high profits and demand.

The new (endogenous) growth theory of cumulative processes gives more space than its Keynesian correspondence for a hypothesis that growth is promoted by pressure. The former theory challenges a proposition in the neo-classical (Solowian) growth theory that higher investment ratios will lead to increases in output levels only, not to sustainable growth. The neo-classical position is weakened if investments are made in human capital and R&D, resulting in sustained growth through either knowledge spillover effects or virtuous circles for the investing firms (Romer, 1990, Grossman and Helpman, 1994, pp. 32-34, Barro and Sala-i-Martin, 1995, pp. 39-40). The new growth theory is in a premature phase and has not yet explored the reasons why the amount and efficiency of investment in human capital and R&D or the assimilation of new knowledge differ between firms, industries and countries. Hence, the door is left open by new growth economists for a theory that growth is stimulated by external obstacles.

Fourth, the new growth theory has hitherto, in spite of its indeterminacy, emphasised the stimulating role of “opportunities” rather than of “pressures”. (Here is a striking similarity between the new growth theory and the Keynesian growth theory.) And more important, a version of the theory of transformation pressure is excluded by basic assumptions in the new growth theory.

The focus upon “opportunities” rather than “pressures” in new growth theory is illustrated by the discussion of a positive relationship between economic integration and growth. Extended markets through trade will strengthen the incentives for R&D investments. Such investments result directly in higher productivity growth but also indirectly through knowledge spillover effects and the emergence of scale advantages in R&D activities. Furthermore, trade of goods will result in learning-by-doing and learning-by-using effects (Romer, 1990, Rivera-Batiz and Romer, 1991, Grossman and Helpman, 1991, 1994). Trade will even promote growth in a small country through the stimulation of the R&D sector according to Gene Grossman's and Elhanan Helpman's growth model. But the expansion of the R&D sector is caused by a release of resources (skilled workers) from other sectors, leading to lower innovation costs, not by a stronger transformation pressure. On the contrary, R&D investments will be depressed, *ceteris paribus*, by international competition. The profitability of R&D decreases when foreign competition is intensified, a relationship

that for a small country will outweigh the positive trade effects on the profitability of R&D from enlarged markets.<sup>2</sup>

Thus, the new growth theory emphasises the market enlargement and cost reducing, rather than the market rivalry, aspects of a positive relationship between trade and growth.<sup>3</sup> It is true that new growth theorists have assimilated Joseph Schumpeter's notion of "creative destruction". But the notion is used correctly to describe the devastating consequences of innovations for established firms (or better, older innovations), not to suggest that these firms will be more innovative when they are challenged as in the theory of transformation pressure. In fact, in new-growth models, R&D investments will be reduced if more creative destruction is expected leading to lower expected monopoly rents for innovations (Aghion and Howitt, 1992).

A theory of transformation pressure is restricted in the new growth theory by a general assumption of constant or increasing returns to scale for investments in human capital or knowledge. The assumption obscures that a departure from an unfavourable growth path may not be easier but, on the contrary, more arduous if the firms acquire more knowledge about existing technologies and markets. An external threat is perhaps needed to persuade the firms to abandon a growth trajectory that is unfavourable in the long run for them or for a particular region, even if investments are made in knowledge and human capital.

Fifth, a relationship between market concentration (or firm size) and innovations is analysed in the neo-Schumpeterian literature, but a link to macroeconomics is often missing (cf. Cohen and Levin, 1989, Scherer and Ross, 1990). The discussion is seldom extended to an analyse of other "pressures" than competition, for instance

---

<sup>2</sup> Grossman and Helpman (1991, pp. 152-154 and ch.9, 1994, pp. 38-41). Grossman and Helpman do discuss a case where trade stimulates growth through intensified competition. But the argument that trade will result in stronger incentives to invent unique products at economic integration concerns the efficiency of R&D investments - a duplication of research can be avoided - not directly the amount of R&D investments. Besides, in their explanation of a positive relationship between international competition and the efficiency of R&D, Grossman and Helpman ignore the possibility that the capabilities of market actors may be extended.

<sup>3</sup> A market-enlargement argument for a positive relationship between economic integration and productivity can also be found in (Horn, Lang and Lundgren, 1995). The authors refer, from a principal-agent perspective, to the use of X-inefficiencies. The reference is controversial - it is "pressures" rather than "opportunities" that lead to stronger efforts in the theory of X-inefficiencies.

from deflationary policies, or interpreted in terms of national growth strategies. However, neo-Schumpeterian theories and empirical studies of market structure and innovations were one source of inspiration when the theory of transformation pressure was developed in the late 1980s and early 1990s.

Neo-Schumpeterian theories of virtuous circles for innovative firms restrict the theory of transformation pressure in the same way as their correspondences in the endogenous growth theory – they exclude the possibility of diminishing returns on investments in knowledge and human capital (see Nelson, 1981). Neo-Schumpeterian economists have discussed, in other contexts, the possibilities of unfavourable growth trajectories, and also of “pressures” other than competition. However, in the exceptional cases where stabilisation policies are noticed by neo-Schumpeterians, higher aggregate demand and profits will mostly stimulate, not curb productivity (growth) as in the theory of transformation pressure. Neo-Schumpeterian economists have a strong preference for Jacob Schmookler's invention theory – high demand will stimulate R&D investments (and other inventive activities) primarily through its positive effects on expected sales but also by improving the capabilities of self-financing (Schmookler, 1966, 1972, pp. 76-77). In Richard Nelson's theory of virtuous growth circles, innovation profits will facilitate the financing of further innovations, not decrease the incentives and efficiency of R&D investments as in the theory of transformation pressure. Consequently, firms that are hit by creative destruction will innovate less, not more, in Nelson's theory, exactly as in the new growth theory (Nelson, 1981, pp. 1046, 1052, 1060).

Sixth, X-efficiency theories and related principal-agent theories assume that external pressure (mostly competition) leads to stronger efforts in firms to reduce production slacks but here, the focus is on microeconomic foundation and allocative inefficiencies, not on macroeconomic applications (cf. Leibenstein, 1979, Frantz, 1992). Few attempts have been made to relate a country's growth performance to the use and amount of X-inefficiencies. Moreover, micro economists in common might have hesitated to embrace a theory about departures from profit maximisation, which hardly is compatible with rational individual behaviour in a dynamic context. The

---

existence of future threats are always real in a market economy even for managers sheltered by monopolistic or oligopolistic conditions who ought to fear product substitutes. It is not obvious why an immediate threat is needed to adjust firm behaviour to profit maximisation.

To summarise, a positive relationship between transformation pressure and productivity growth has either been ignored or not been defined in macroeconomic terms in Anglo-Saxon economics. However, the integration of neo-Schumpeterian and new-growth models in recent years has meant a growing support to a theory that more intense competition is growth-enhancing (Aghion, Harris and Vickers, 1997). Besides, empirical studies in the 1990s have uncovered the importance of either domestic competition (Porter, 1990) or global competition (Baily and Gersbach, 1995) for international competitiveness and differences in productivity.

Below, I will describe the theory of transformation pressure and anchor it on the firm level. Similar Anglo-Saxon theories will not be accounted for unless they illuminate important aspects of, or differences to, the theory under discussion. Such theories, however, will be noticed in a separate section if they give arguments against a theory of transformation pressure. In a subsequent section, qualified theories of transformation pressure are formulated taking account of the role of positive incentives in the growth process. I will then discuss the scientific and political implications of the theory of transformation pressure. The paper is completed with a summary of its main theses, a new reference to Swedish productivity growth, and a suggestion of further research.

## 2. The definition, components and theory of transformation pressure

“Transformation” is often defined in broad macroeconomic terms in the growth literature covering, e.g. the reallocation of productive resources between business sectors and the change in overall demand compositions. I prefer here an alternate, microeconomic, definition, as my aim is to anchor the theory of transformation pressure on the firm level. Furthermore, I consider only changes that, more or less intentionally, leads to increases in firms' total factor productivity. For instance, new

regional market orientations for established products will be ignored unless they are associated with scale advantages or improvements in product quality.

The concept “transformation” covers the introduction of new products, production technologies and work organisations but also new ways of management, marketing, distribution, stock keeping, administration and finance. It also includes (every-day) rationalisations and other efforts by the companies to raise total factor productivity within the existing structure of products, technologies and organisations. However, I will not include mesoeconomic measures such as mergers or take-overs to exploit economies-of-scale. In addition, I will not consider companies' attempts to circumvent external threats by market collusion or political pressure to get subsidies, tax redemption or sheltered market positions.

The notion of “transformation” is more general than that of “innovation” in my paper. I reserve, as often the case in industrial economics, the concept “innovations” for new products and technologies only. I will pay a particular interest to "radical transformations", thus to major changes of product patterns and technologies (and also of organisations). The opposite notion of "status-quo strategies" covers the cases where firms follow a familiar growth trajectory in terms of products and technologies. A firm that carries on a status-quo strategy is occupied with rationalisations, product differentiation and minor changes in technologies (and organisations).

I will define transformation pressure as follows – immediate external events or developments imply a real threat to a company in the sense that it has to be transformed to avoid a high risk of closure or a significant reduction in profitability. The question is kept open whether the transformation process is shaped by a status-quo strategy or by attempts to generate and assimilate radical innovations.

Market competition is the most obvious form of transformation pressure. A firm is hit by a stronger external pressure if other firms are more innovative or more able to adapt new ideas. There are, of course, other aspects of market rivalry and also of other transformation pressures than market competition. The overall pressure is partly determined by the size and nature of exogenous demand. Firms may suffer from low demand growth or meet stronger customer claims on product differentiation and better



services. The importance of qualified domestic demand for innovations is emphasised by industrial economists (Porter, 1990, p. 90).

An external pressure on a firm will also emerge if “prices” on labour, raw materials, energy and capital are raised by other reasons than the firm's own factor demand. For instance, higher nominal wages reflect a higher external pressure if they are induced by investments by other firms or lower labour participation rates. As a consequence, the firm now has stronger incentives not only to substitute machines for labour in production but also to raise total factor productivity. (The two ambitions can, of course, be realised simultaneously by the use of labour-saving new technologies.) The firm may choose to upgrade labour by on-the-job training. Limited possibilities for the firm to mark up increases in unit wage costs will also lead to higher total factor productivity if they induce innovations or reductions in internal inefficiencies. Such reductions can be achieved by general measures or specific ones to economise on labour.

Transformation pressure may also be raised by political interventions such as environment regulations and industrial and stabilisation policies. For instance, revaluations in a fixed exchange-rate system will reduce national cost competitiveness unless they induce increases in total factor productivity in the exposed sector. The emergence of a comparative disadvantage after a revaluation assumes imperfect labour and capital markets preventing an instant reduction in wages and interest rates. As will be developed later, companies have strong incentives to raise productivity if new revaluations are expected. In this case, they have strong incentives also to pursue measures that lead to sustainable growth.

The theory of transformation pressure says that aggregate productivity will increase with a delay if a significant number of companies are actually hit by a harder external pressure. Moreover, a stronger pressure is supposed to stimulate not only productivity but also productivity growth in the economy by raising firms' abilities and willingness to produce and adapt new knowledge or their competence in general. Harder pressures may also stimulate aggregate productivity growth if they result in (external) structural change or investments by single firms with knowledge spillover effects.

Rationalisations are exceptions from the rule that external pressure will stimulate not only productivity but also productivity growth. However, an assumption that rationalisations result in higher productivity growth would not have been entirely inaccurate. Downsizing may facilitate the financing of R&D investments and also be associated with organisational changes that raise the incentives and acceptances of technical changes in the firms. Besides, large rationalisations may have a decisive influence on average productivity growth during a certain period.

As already noted, separate changes in external pressures will be neutralised, more or less instantly, by developments on labour, product and financial markets. Negative shocks on product and factor markets for firms that are exposed for foreign competition are counterbalanced by depreciations of the currency at floating exchange rates. Analogously, positive shocks will not ease the transformation pressure on exposed firms because of appreciations. Similar tendencies towards an "equilibrium" pressure (and a constant rate of profit in the long run) will also emerge in a fixed exchange-rate system particularly through adjustments of nominal wages and money supply.

According to the theory of transformation pressure, aggregate productivity growth will increase whether the companies are transformed or not. A phasing-out of business activities or an elimination of companies (or production units) suffering from external pressure will release resources to be used by companies (or production units) with higher productivity levels or growth. In this case, productivity growth on the aggregate level is raised due to (external) structural change. However, I will not pay any further attention to this, rather uncontroversial, explanation of a positive relationship between external pressure and productivity. My focus is on the consequences of external pressure for the productive performance of established firms.

### 3. Microeconomic foundation

The theory of transformation pressure must be build up in two steps. First, I have to explain why firms' productivity growth is stimulated by a decline in expected

profitability. Second, I must state the reasons why a reduction in actual profitability is needed to get a productive response from firms.

A theory that productivity growth is stimulated by expected external threats is not obvious in economics, particularly not as far as investments in R&D are concerned (see the introduction). According to the common view, investments are hampered by predictions about lower profits. But arguments that productivity growth is promoted by worse prospects can even be found in the mainstream literature. One argument is that depressing prospects for particular product markets will raise investments by established firms in other product areas. Heavy investments are demanded if a transition to new markets is associated with high fixed costs. Overall productivity growth may be raised through embodied technological progress or changes in industrial composition.

Another explanation of why investments are unaffected or even promoted by discouraging prospects is that investments are strategic. Firms will invest even if the net present value is negative as they are governed by an ambition to stay in business. Strategic investments may reflect the prevalence of firm-specific goals and industry-specific competencies of managers (and other employees) possibly in combination with non-pecuniary values among owners. Established owners may strive for the survival of a firm if they fear losses of prestige or have feelings of affinity.

There is a third plausible explanation of a negative relationship between expected profitability and investments. Efforts by firm actors to raise total factor productivity, e.g. by searching for profitable investment options, may be stimulated by expected external challenges. Such efforts in a threatened firm may be explained by firm specific interests (see above). Principal-agent models offer another explanation. In (Hermalin, 1992), fiercer competition will lead to stronger managerial efforts when income effects dominate over leisure-substitution effects. The assumption is made that managers' expected income is a function of expected profits (see also Scitovsky, 1943).

However, the theory of transformation pressure is not identical to a theory that productivity growth is stimulated by expected threats. I assume that firms will only

transform if the challenges are instant – a threat in the future is ineffective if not corresponded or indicated by real threats today. The main challenge of a theory of transformation pressure is to explain why an obvious outside threat is needed to realise a transformation of a company. Rational managers and owners ought to take steps already in good times to ensure the survival of the company as threats in the future are inevitable.

I will present three arguments for a positive relationship between immediate external pressure and productivity – genuine uncertainty, irrationality and the importance of "difficulties" for creativity and skill formation. The third case concerns the abilities rather than the incentives of firm actors.

### 3.1. Genuine uncertainty

A theory that a company must experience an obvious threat to rationalise, reorganise or look for new techniques and market opportunities is compatible with an assumption of genuine uncertainty. A company that waits and sees cannot be accused of lacking foresight when future is veiled in complete obscurity. In this case, a rational firm will only react when the threat is real. The existence of genuine uncertainty for established companies is probably most striking where product substitutes and political interventions by unstable parliamentary and governmental coalitions are concerned.

The uncertainty concerns the nature and extent of future challenges. A complete certainty that threats will appear, in some disguise, is not enough to induce rational firms to transform. The strategy by managers and owners to rule their thumbs until the threat shows up is probably the best choice when the character and extent of the challenges is unknown. Rational firms will then postpone responding even if they, for excellent reasons, are convinced that, for instance, a stronger competitive pressure is inevitable in the future. The risk is impending that impatient firms will make the wrong investments in the light of subsequent decisions by competitors. For example, established firms might have put all their R&D resources in product differentiation on markets where new process technologies later appeared to be the great challenge by newcomers.

The arguments for being inactive until the threats show up are strengthened if the firms are risk averse at the existence of instrument uncertainty thus, at difficulties to predict the consequences of their own actions. Managers and owners have often more information about the consequences of status quo like strategies than of radical transformations (Greenwald and Stiglitz, 1993, p. 28).

In some cases, rational firms will wait and see even if the threats have really shown up. The nature of the challenges is not always unveiled by their appearances. A response is only required if a negative shock indicates a long run threat to a company. This cannot be taken for granted as illustrated clearly by the business-cycle aspect of transformation pressure. A firm has to decide whether a negative macroeconomic shock is a temporary or a permanent phenomenon. For instance, Western producers of low-technology products had to distinguish in the mid 1970s whether the decline in demand was due to macroeconomic imbalances or to harder competition from Japan and newly industrialised countries. A firm must also find out whether a particular demand or cost shock is firm or industry specific.

However, rational firms may postpone reacting even if the character of a threat has been revealed by its appearance. The extent of a challenge cannot always be distinguished at once. For example, entry by a new innovative firm is not automatically a threat to established firms. A response by the latter firms is only necessary if it gradually becomes clear that the new firm has a large market potential (Utterback, 1994, pp. 162-163).

A theory that firms will only react on external threats that have really shown up does not preclude the possibility that firm decisions are governed by expectations. I have suggested above that the nature and extent of a threat is not always shown by its appearance. A rational firm has to decide whether it is better to postpone a reaction to an obvious threat to get (more) information about the character and scope of a challenge or act on the basis of (current) expectations. I will assume that the probability of a response will increase in the course of time as uncertainties about the nature and consequences of an open threat are successively reduced. The assumption accords with my basic notion that firms will not transform until a challenge has actually taken place as the character and size of future threats cannot be accurately

predicted. But the assumption does not exclude the possibility that the reactions on real challenges are guided by expectations. Firms must often respond before they have full information about the character and scale of an apparent challenge.

To induce a response, a negative shock, which by definition is totally unexpected, has to result in expectations that new external circumstances will prevail or that similar events will show up regularly and not be counterbalanced by positive events ("opportunities"). Thus, firms will only transform if they think it is likely that individual external challenges have long-lasting effects or will be followed by similar challenges in the future. Another necessary condition for a response is, of course, that the challenge, if not accepted, will result in a significant reduction in expected profitability. For example, a revaluation of the currency will only lead to transformations if the companies expect that the currency will be overvalued for a long time, because of slow market adjustments or supporting new revaluations, and that their profitability will be strongly reduced at passivity.

My explanation of a relationship between immediate pressure and productivity growth above is similar to Herbert Simon's theory of procedural rationality. According to Simon, it is unlikely that firms will make the best decisions in a world of large uncertainties and difficulties to foresee the consequences of their actions. But firms are rational if they are learning by experience, that is, if they make better decisions when the consequences of their older ones have become obvious (Simon, 1978, pp. 8-9). Simon's theory is compatible with a theory of transformation pressure saying that firms in a world of large uncertainties will only respond efficiently to threats that are manifest.

A difference between the two theories is that, in Simon's theory, firms will not wait but make decisions that probably appeared to be wrong in retrospect. Here, Simon refers to substantive irrationality, not to probabilities and attitudes to risk. In the theory of transformation pressure, the arguments of genuine uncertainty and irrationality are separated. In next section, I will explain a positive relationship between immediate outside pressure and productivity in terms of (substantive) irrationality. A firm will not always react on external threats before they appear even if their character and consequences are easily predicted. Here, waiting will not

improve the quality of decisions as in Simon's theory or in the theory of transformation pressure based on an assumption of genuine uncertainty.

A theory that firms will postpone reacting on future threats to get more information has a resemblance with the theory of investment under uncertainty (Dixit and Pindyck, 1994, Hubbard, 1994). In the latter theory, investments are irreversible (have sunk costs) and are possible to postpone. It may be rational to delay an investment to get more information about its benefits and variable costs. More uncertainty over net benefits will, *ceteris paribus*, increase the value of waiting.

The irreversibility of investments and the possibility to postpone them are implicit assumptions in the theory of transformation pressure. Another similarity between the theories is the notion that rational firms may delay strategic decisions to procure more information about demand and cost conditions. But there is some dissimilarity between the theories.

In the theory of investment under uncertainty, the value of waiting emerges through the continuous stochastic development of future benefits and variable costs. By waiting, the firms will get new information about the stochastic process. On the other hand, firms are supposed to have full knowledge about the trend in net benefits of an investment project. It is true that discontinuous "events" such as harder competition, leading to a reduction in expected profits, are not known by the firms in the theory of investment under uncertainty - such events will appear at some date with a certain probability. But the theory under discussion gives no room for an assumption that firms will learn more about the character and nature of such events by waiting. It assumes that the nature and consequences of future threats are known. The firms are only uncertain over whether the threats will show up or not during a specific period.<sup>4</sup>

In the theory of transformation pressure, firms will delay investments to get more information not only of stochastic processes (which are of no interest per se in the theory) but also of market growth, (variable) cost developments or the nature and

---

<sup>4</sup> Dixit and Pindyck, 1994, 167-173, Hubbard, 1994, pp. 1822-1823. A negative event is described in the theory of investment under uncertainty as a Poisson jump "downward" in the value of an

extent of competitive threats. The difficulties to separate market-stochastic, market-growth and market-competitive phenomena in a turbulent environment is a particular argument for a wait-and-see position in the theory of transformation pressure.<sup>5</sup>

A basic difference between the two theories is that investments by incumbent firms are conventionally stimulated by "opportunities" such as protected markets, high demand or low variable costs in the theory of investment under uncertainty. In the theory of transformation pressure, investments by established firms will be promoted by hard competition, low demand or high variable costs if their transition to new markets, strategic investments or efforts to find new investment options are speeded up.

A theory saying that firms will not transform until the threats are real, as future challenges are extremely difficult to predict has its limitations. First, some future challenges are possible to predict with a certain probability. Second, a status quo option may be more risky than a radical transformation if uncertainty about external conditions rather than instrumental uncertainty are considered. The risk of meeting external threats may actually increase if the firms are inactive.

Third, I have hitherto ignored that foresight is a virtue even at genuine uncertainty. Today, companies' competitive strength is to a large extent defined by their ability to adjust to unexpected events. By the introduction of flexible technologies and organisations, a company shows good preparedness to meet potential threats rather than good predictability. Thus, it may be logic to claim that foreseeing investments have been made in this case in spite of the fact that firms will not adjust to external events before they are in sight.

---

investment  $V$  (at some random point in time) with a mean arrival rate  $\lambda$ . An event with probability  $\lambda dt$  will reduce  $V$  by some percentage  $\phi$  (where  $0 < \phi < 1$ ) with probability 1.

<sup>5</sup> In fact, the probability of a negative event  $\lambda$  (a downward Poisson jump) will reduce the value of waiting in the theory of investment under uncertainty. It reduces the expected value of an investment  $V$  that means a smaller opportunity cost of investing now rather than waiting. A counterbalancing effect will emerge through an increase in the variance of  $V$ . But the latter effect is not strong enough to increase the value of waiting (Dixit and Pindyck, 1994, pp. 171-172). In any case, there are no place in the theory under discussion for an argument that firms may find it valuable to wait until the threat shows up (or is close at hand) to get more information about its character and consequences.



A theory that companies will not invest in new products, technologies and organisations until the threats are real because of uncertainties cannot be the theory of transformation pressure. It remains to explain why some companies postpone, for instance, the introduction of flexible technologies and organisations to the date when external pressure is raised. In next section, I will cultivate my argument in isolation by not assuming genuine uncertainty. Managers and owners are supposed to be able to make rather good predictions of threats and opportunities at least if they spend sufficient efforts on search activities.

### 3.2. The psychology of a resistance to change

Firms will not always pay attention to future challenges and possible investment options (and their profitability) even if the costs of collecting reliable information are low. Moreover, firms will not respond under all circumstances even if they already possess adequate information about possible threats and investment alternatives. I assume that a transformation would have increased expected profitability and the chances of survival. A further assumption was made at the end of last section - a transformation is not withheld because of a large variance in profitability. Below, I will even preclude the possibility that the variance in profitability is significantly raised by a transformation.

Rationality is the assumption per excellence in microeconomics. This is true also in theories of the firm. Although agents refuse to maximise profits on certain occasions, they are maximises of utility at least. Departures from utility maximisation under a budget constraint only are not explained by "irrationality" in neo-classical theory but by the existence of information and transaction costs (De Alessi, 1983).

In fact, Harvey Leibenstein does not challenge the assumption of rational behaviour in his criticism of conventional microeconomics. "Selective rationality" does not reflect any irrational behaviour, only that managers and workers abstain, under some circumstances, from profit maximisation to satisfy their individual interests (cf. Leibenstein, 1979, pp. 484-485).

---

The divergence between profit and utility maximisation behaviour will be reduced at an outside pressure according to the literature on X-inefficiencies. But it is difficult to see how any departures from profit maximisation are compatible with utility maximisation in the long run. I have already assumed that static firms will inevitably experience external shocks in the future. A conflict between profit and utility maximisation is reduced if managers' expected incomes are functions of expected profitability as emphasised in (Hermalin, 1992). But there is still plenty of room in the principal-agent literature for the possibility that managers will refrain from profit maximisation. The willingness of rational (utility-maximising) managers to deviate from profit maximisation is probably exaggerated in the literature. First, managers' incomes, comfort and prestige in the long run depend on the profitability and, even more, the survival of the firm where he or she is employed today. A "utility-maximising" manager must have strong incentives to reduce the probability of closures and hostile takeovers, for instance, by searching for the best investment options. Second, a proposition that managers can permit themselves to rest on their oars in good times can be questioned if a radical transformation would have increased the firms' chances of stable profitability and survival. Besides, the possibilities to realise a radical transformation may increase at a permanent profit maximisation. High actual profits and profitability will probably raise the firms' ability to self-finance investments and get external capital.

Empirical indications that companies are maximising growth (of production, sales or market shares) do not reject a theory that they follow a profit maximisation principle in the long run. Fast-growing companies might gain from scale advantages or learning-by-doing effects, either in marketing, production or R&D. It is true that companies can strive for high production growth or larger market shares at the expense of high profitability for instance, by pursuing an aggressive price policy. However, the ultimate aim of the strategy is to obtain high profitability in the long run by the elimination of old rivals or the deterrent of new ones. Below, I will only consider cases where long run profitability and the survival of the firm are obviously jeopardised by the behaviour of firm actors.

My second explanation of why productivity will increase when external pressure is raised assumes that the agents will first be rational when the firm is put under an

obvious threat. Consequently, the firm is not always maximising profits in practice even if all actors espouse the goal as a guideline by the simple fact that it is in their own interest. In good times, firms will not try to ward off future threats even if uncertainty is low, the objective risks of large losses are high and the costs of collecting information about possible threats and investment options are low. There are two psychological reasons why a necessary transformation of firms is not made until the threats are real – self-deception and discomfort.

Self-deceptive managers, owners and workers are lulled into a sense of security and stunned by earlier successes when historical profits are high. Managers and main owners become over-optimistic about the profit prospects of driving the firm into old wheel-tracks. For instance, the pressure from main owners on managers is weakened when historical profits are high. They may not endeavour to find out whether the success of the firm is due to favourable external conditions or internal competence.<sup>6</sup> Firm actors can first be persuaded to abandon an ungrounded sense of stability and personal quality at an obvious threat.<sup>7</sup>

The risk that companies overestimate their abilities and become intoxicated by earlier successes is probably higher if high actual profits depend on favourable external conditions, such as an undervalued currency, rather than on transformation in the past. Easily earned incomes can easily be confused with incomes from a dynamic behaviour. Besides, the risk of self-deception is often stronger if necessary changes in the companies demand individual efforts.

The need of efforts may postpone a transformation of a company not only by reinforcing the tendencies to self-deception but also per se. Transformation efforts are particularly painful for managers and established stockholders if old habits in the

---

<sup>6</sup> I will not exclude the possibility, central in principal-agent models, that it is easier for owners to control (monitor) managers on competitive markets because of greater opportunities for firm comparisons. Under such market conditions, industry-specific negative shocks will induce stronger managerial efforts through harder pressures from owners (Nickell, Nicolitsas and Dryden, 1997, p. 785).

<sup>7</sup> Empirical studies have not unambiguously shown that well-performing organisations prefer options that are more risky in terms of losses (Davis, Kameda and Stasson, 1992, pp. 191-192). However, the discussion above emphasises the importance of past successes for firms' estimations of risks and future outcomes, not their attitudes to risk per se.

company are challenged or if the relations to the employees must be characterised by claims, threats (e.g. of dismissals), persuasions or reorganisations. Feelings of unpleasantness among managers and owners towards the undertaking of necessary changes of the company can only be suppressed at an immediate external threat.

Hence, an inevitable transformation of a firm is postponed either by thinking in grooves, the fear of challenging consensus or the fact that earlier successes make the firm too optimistic about the advantages of its traditional growth strategy. A theory of transformation pressure might learn from modern social psychological literature on the importance of habits and unity for decision making. The literature also emphasises that attitudes, e.g. to risk, may be influenced by earlier choices (Eiser and Pligt, 1988, Ch.2, Yates, 1992).

References are often made in psychology to Pearl Harbor in December 1941. The U.S. Naval Commander (and his advisors) resisted a full alert and an evacuation in spite of a high probability of a Japanese attack. The Commander's choice of status quo reflected that he underestimated the risks and costs of an attack and took up a risk-prone attitude. The status quo position by the U.S. Navy at Pearl Harbor has been explained in the psychological literature by "groupthink", that is by conformity pressures and shared illusions within a small cohesive group. The risk of groupthink is overwhelming if the group is dominated by powerful leaders or lacks clear decision-making procedures (Davis, Kameda and Stasson, 1992, pp. 189-190).<sup>8</sup>

Some economists may insist that the resistance to change above may reflect rational behaviour regardless of the value of waiting discussed in the preceding section. Firms' reluctance to a change that would have increased expected profitability and the chances of survival may be explained by the fact that changes are associated with efforts and discomfort. Moreover, if changes are risky, a resistance to a transformation that would have resulted in a significant increase in expected profitability and the chances of survival may reflect that the actors are risk seeking or

---

<sup>8</sup> Psychological studies have shown that decisions by (small) groups may be more extreme (risk-prone) than individual decisions (Davis, Kameda and Stasson, 1992).

lack information. But such views will either water down the notion of rationality or violate some axiomatic assumptions behind expected profitability (and utility) theory.

Let us first assume that the firms can easily acquire reliable information about the consequences of, for instance, a status-quo strategy and a radical transformation. A strong resistance to a transformation, although strenuous and unpleasant, cannot be labelled rational if all actors will benefit from a change and unanimously support it *ex post*. In fact, the values of the actors may be altered at the departure from a status-quo strategy.

Let us abandon, however, the assumption that the outcomes of a status quo and a radical strategy are fully known. I will assume that the status-quo alternative is associated with a higher risk of large reductions in profitability than the radical transformation. This assumption is similar to the one at the beginning of the section focusing on transformation *per se*. But it concerns changes rather than levels of profitability and more specific, negative changes in profitability ("losses"). In fact, the case is equivalent to the specific one of Pearl Harbor above. Actors will run a large risk of serious losses if they choose a status quo option.

In Daniel Kahneman's and Amos Tversky's prospect theory of decision-making, firms may prefer a status-quo position even if a radical transformation is associated with a higher expected profitability, see Kahneman and Tversky, 1979, 1987. (Expected profitability is obtained by weighting the different outcomes with their respective probability.) The choice of status quo reflects a risk seeking behaviour if the probability of large losses is high in accordance with my assumption above.

Risk seeking is not an assumption in Kahneman's and Tversky's theory but a psychological principle unveiled by experimental studies. Decision-makers underweight outcomes with high probabilities but overweight outcomes that are certain or have low probabilities. (Kahneman and Tversky use decision weights, not probabilities, to calculate the value of different options.) Thus, actors put a low weight on outcomes with a high probability of large losses. This behaviour may lead to the choice of status quo in spite of a significant risk of large losses. However, I

must assume that the smaller losses at a radical transformation are almost certain. (See people's overweighing of certain outcomes in the prospect theory.)

The odds for status-quo choices become even higher in Kahneman's and Tversky's theory if positive profitability changes (gains) are noticed. Let us assume that small gains are almost certain with this strategy while an alternative radical strategy has a significant probability of large gains. Again, firms will choose a status-quo position as they are supposed to overweight certain but underweight probable outcomes. Thus, firms are risk averse where profit chances ("opportunities") are concerned.

Kahneman and Tversky do not claim that the choice of status quo above is rational. On the contrary, the risk is evident that the choice will violate basic principles underlying the expected profitability theory.<sup>9</sup> Separate comparisons of gains and losses make it difficult to distinguish changes in net profitability or in the rate of survival. If comparisons of gains and losses are integrated by studies of net profitability or rates of survival, the chances are greater that a radical transformation satisfying expected profitability theory will be selected. A more rational behaviour reflects that the choice situation has become more transparent, that is, that the decision-makers can more easily survey and evaluate which alternatives are superior (dominant) in terms of probabilities and outcomes. However, complete transparency is unrealistic, a conclusion that opens the door e.g. to irrational choices of status quo (cf. Kahneman and Tversky, 1987, pp. 87-88).

Kahneman's and Tversky's prospect theory strengthens the argument that firms choosing a risky status quo option are irrational. But the theory of transformation pressure is not based on risk considerations in the first place. Kahneman and Tversky do not discuss, for instance, why firms' search for alternative options is half-hearted under some external conditions. Furthermore, my explanation of why firms refuse to transform without an immediate threat emphasises the importance of habits, unity-seeking and the tendency to underestimate the probability and amount of losses of a

---

<sup>9</sup> The principles of dominance and invariance may be violated. Dominance means that if A is preferred to B in one state and considered as least as good in all other states, A should be chosen. Invariance means that decision-makers' ordering of alternatives shall not change as a consequence of an alternative description of the same problem - see the possibility to describe options in terms of gains and losses or net profitability!

status quo strategy, a tendency that is stronger if firms have been successful in the past. The explanation is not primarily based on any recognition of attitudes to risk.<sup>10</sup>

An assumption of maximising agents is both unnecessary and a straitjacket at the formulation of a theory of transformation pressure. The assumption increases the risk that illuminating psychological theories of a resistance to change will be ignored. For instance, a theory saying that individual values and beliefs are distorted by external circumstances and earlier choices may escape our attention.

I will assume that the reluctance of companies to face inevitable challenges unless they are real might be systematic. With this assumption, an individual temptation in good times to ignore possible threats turns into a social-psychological phenomenon. Thus, an actual external pressure, through tighter competition, dwindling market opportunities or higher production costs, will have a positive impact on aggregate productivity if a sufficiently large number of companies are hit. Consequently, my second explanation of a positive relationship between transformation pressure and productivity is relevant for macroeconomics.

### 3.3. Necessity is the mother of invention

The phrase that necessity is the mother of invention suggests that people becomes more creative when they are put under a strong pressure. A specific theory states that the ability of established firms to produce, assimilate and use new ideas will increase at an immediate threat. Through these enlargements of capabilities, the firms can combine productive forces in a way that they had never thought of before. The disentanglement of creative forces may have positive effects e.g. on the amount and efficiency of R&D investments.

---

<sup>10</sup> There is another striking difference between the theory of transformation pressure and Kahneman's and Tversky's prospect theory. In the latter theory, experiences of large losses make people more risk seeking thus, their reliance on risky status-quo strategies will be deepened (Kahneman and Tversky, 1979, pp. 286-288).

A theory that troublesome external conditions stimulate not only efforts but also creativity (and skills) in the firms is not far-fetched for anthropologists and historians (see Toynbee, 1949). Although discussed in works on the competitiveness of firms and nations, the idea that necessity is the mother of invention is uncommon in mainstream economics. Microeconomic theory does consider that firms have incentives to use and develop technologies that economise on scarce resources. But the theory of transformation pressure takes a step further – it assumes that factor scarcity will stimulate the ability to develop and adapt resource-saving technologies and organisations. Here, industrial economists often refer to the Japanese experience. Shortage of raw materials and capital after World War II speeded up not only the use but also the development of factor-saving technologies and organisations. This theory must be added to other explanations of why the losers in World War II showed relatively high productivity growth in the early postwar period. Endogenous and neo-classical growth theories say that human capital was kept intact (Barro and Sala-i-Martin, 1995, pp. 200-201), physical capital stocks were initially small (Solow, 1956) and that old (inefficient) production vintages were eliminated during the war permitting the adoption of new technologies (Solow, 1964).

But a theory that firm creativity is stimulated by external pressure is not restricted to the cases of resource scarcity and resource-saving activities. Firms will be more innovative in general if they are put under an external pressure whether its character. A bold hypothesis is that the Japanese defeat in World War II per se laid the psychological ground for the country's following industrial success.

A related theory is that experiences of external pressure will increase the skill of managers and workers. The agents are assumed to be more capable, for instance, to meet new threats if they have been persecuted by earlier threats. A positive relationship between experience and the quality of human capital is considered in growth economics. But the "opportunity" notions of learning-by-doing and learning-by-using in growth economics must be supplemented with that of learning-by-hardship. The latter concept covers the possibility that experiences of tough external conditions will improve the skills of managers and workers.



Innovations are stimulated by transformation pressure both in the theory of a profound individual resistance to change and in the theory where necessity is the mother of invention. The difference between the theories is that efforts and attitudes of firm actors are centred in the former theory, not their creative ability and competence as in the latter one. In practice, a separation between the theories is difficult, thus to decide whether innovations enforced by real external threats are acts of volition or reflections of enlarged abilities. Learning-by-hardship and creative thinking under the gallows may require efforts and also shape the values of the actors in the firm.

#### 4. The theory of transformation pressure is not a natural law!

The theory of transformation pressure does not cover all theories about a positive relationship between competition and productivity.<sup>11</sup> But more important, hard external pressure in general, and tough competition in particular, may hinder productivity growth. Theories of a negative relationship between external threats and productivity are the real challenges to a theory of transformation pressure. They concern the incentives and efficiency of investments (especially in R&D), learning-by-doing, the attitudes to transformation and the quality of management and labour.

Industrial economists have asserted that the propensity to engage in costly R&D activities is low at intense market rivalry, as the probability of being the successful innovator is small. Besides, R&D investments will be low on markets with low entry barriers, or with many potential R&D investors in general, as the costs of failure are too large and the expected innovation profits too small (Scherer, 1984, p. 291, Scherer and Ross, 1990, pp. 637, 643, Scherer, 1992, p. 1420, Aghion and Howitt, 1992). A common argument in investment theory is that tough external circumstances make self-financing more difficult as historical profits are squeezed. The desire of self-financing and the cost of borrowing are assumed to be exceptionally high for risky

---

<sup>11</sup> My emphasis on the threat (or pressure) aspect of competition excludes, for instance, a theory that R&D efforts are stronger if there are many rivals because of greater prospects of temporary monopoly profits. The theory is based on an assumption of symmetric market positions - the innovator (first mover) will gain market shares in proportion to the total number of rivals (potential innovators). My threat perspective also excludes, together with my focus on firm behaviour, theories that the probability of technological break-through will increase with the number of firms (Scherer and Ross, 1990, pp. 636, 643).

R&D investments. In addition, investments in R&D may be stronger on markets with few producers as the possibilities to benefit from positive spillovers between various R&D programs, spread risk and raise (cheap) external capital are larger in big companies (Scherer and Ross, 1990, pp. 652, Scherer, 1992, p. 1422, Symeonidis, 1996, p. 21). Besides, investments that embody new technologies may be hold back by low demand, thus dynamic scale advantages cannot be captured.

Economic historians have claimed for Swedish industry that decades with high transformation pressure were characterised by rationalisations and labour substitution rather than by innovations and capacity-augmenting investments (Schön, 1990). A macroeconomic theory can be formulated saying that periods with hard external pressure will be dominated by rationalisations rather than by radical transformations, thus by measures leading to non-recurring productivity lifts rather than to sustainable growth. Some industrial economists support the view of a conflict between rationalisations and investments leading to sustainable growth. The firms must make a choice between “differentiation” and cost effectiveness (Porter, 1990, pp. 37-38). But it remains to explain why rationalisations are chosen before radical transformations at a stronger external pressure.

Imperfect capital markets can explain the priority of rationalisations in hard times. It may then be difficult to raise funds for the financing of (long run) investments. A rationalisation bias can also be explained by risk aversion if a radical transformation is associated not only with higher chances of large profit gains but also with higher risks of large profit losses. A specific hypothesis is here that the risk of bankruptcies at an immediate threat enforces the firms to be myopic and spend their resources and efforts on short-run, cost reducing activities to survive. But rationalisations may be chosen even if the risks of profit losses and firm death are larger with this strategy (Cf. Kahneman's and Tversky's prospect theory of irrationality.) Furthermore, an "irrational" choice of rationalisations instead of radical transformations in hard times may reflect that the use of a status-quo strategy has led to ungrounded feelings of optimism, invulnerability and comfort. (Cf. the psychological mechanisms behind a resistance to change per se under prosperous conditions.) Rationalisations may also be

---

prioritised in troublesome periods if uncertainty about future outcomes (the variability) is lower for a status-quo strategy than for a radical transformation. Finally, the freeing of creative human energy at an external pressure may be directed towards every-day measures to raise productivity rather than to path-breaking innovations.

Hard external pressure may have a negative impact on the efficiency of investments even if they intend to radically transform the firm. The risk is impending at intense competition that firms' R&D projects are exactly identical or carelessly hastened. Furthermore, low demand and many producers can hamper the efficiency of investment if there are significant static returns to scale in production, marketing and R&D.<sup>12</sup>

Another reasonable argument, although infrequent in industrial economics, is that a tough competitive climate makes learning-by-doing more difficult. Managers and workers in dynamic branches, characterised by a steady stream of innovations, have no time or capacity to assimilate all new knowledge. Hence, even if a firm becomes more innovative at a competitive pressure from innovations by other firms, productivity growth may be hampered by a trade-off between the production and assimilation of new knowledge.

A serious competitive challenge may also weaken a firm's belief in the future and self-reliance leading to inactivity and feelings of inferiority among managers and employees. Besides, a strong transformation pressure may reduce the quality of management and labour. Actors in the firms may be burned out and make hasty decisions if the competitive pressure is too hard. (A negative relationship between competition and the quality of R&D investments has already been considered above.) Intensive competition may, for example, deteriorate the quality of decision-making if the managers become stressed by high risks of large losses or insufficient time to search for profitable options (cf. Mann, 1992, pp. 208-211).<sup>13</sup>

---

<sup>12</sup> Of course, there are arguments in industrial economics that large firms are less vigorous innovators than small firms emphasising e.g. the possibilities of diseconomies-of-scale and that small firms are more adept to risk taking (Scherer and Ross, 1990, pp. 652-653, Scherer, 1992, p. 1422).

<sup>13</sup> One explanation in the psychological literature of the U.S. passivity at Pearl Harbor put the blame on transformation pressure! The stress from the threat of a Japanese attack explains why the U.S. Naval Commander wrongly chose an unnecessary risky option (Davis, Kameda and Stasson, 1992, p. 189-

All theories above are no serious challenges of a theory that productivity is stimulated by hard pressure. This is certainly true for the theory that companies prioritise rationalisations (and other “defensive” actions to raise cost competitiveness) in troublesome periods. First, the latter theory calls in question the dynamic nature of transformation when external pressure is hard, not the hypothesis that a transformation will actually occur. Second, an antagonism between rationalisations and innovative efforts may be weakened (although not entirely eliminated) if the managers are foreseeing and competent enough to combine the two activities for instance by pursuing a "mass customisation" strategy. The strategy is based on flexible production techniques and the creation of unique products (Utterback, 1994, pp. 97-99). In fact, successful companies on world markets seem to be both cost effective and innovative in comparison to other companies (Ingenjörsvetenskapsakademien, 1991). Third, empirical indications that rationalisations are prominent in a recession are compatible with a theory of transformation pressure saying that the use of both production slacks and investment opportunities was deferred during the preceding boom. A cost-hunting bias will then emerge in the recession as the potential for rationalisations is large and the needs to rely on such measures to survive may become urgent.

Anyway, the challenges to a theory of transformation pressure are serious enough, at least if sustainable growth is concerned, to either crush the theory or call forth a profound revision. I will formulate a qualified macroeconomic theory below that considers the amount, character and duration of transformation pressure.

---

191, Mann, 1992, pp. 201-202). However, the explanation is not confirmed by other psychological studies showing that decision-makers become more cautious and risk-averse under time pressure (Mann, 1992, pp. 213-215).

## 5. An optimal transformation pressure

### 5.1. The optimal theory of a moderate pressure

Diverging theories about the relationship between transformation pressure and productivity growth seem to offer a strong case for a theory that the optimal pressure in each period is lower than the maximal one. A plausible theory is that productivity growth will increase at more pressure but only up to a certain point.<sup>14</sup> The external pressure in each period must be sufficiently hard to enforce the companies to be innovative and efficient but not so hard that their R&D investments become too risky, overshadowed by rationalisations, impossible to self-finance or the source of too short monopoly periods. Moreover, the difficulties to exploit scale advantages, spread risks and learn by doing may be overwhelming at an exceptionally strong pressure on the companies. Extreme pressure may also produce defeatist attitudes and erode the quality of human capital and decision making in general.

A theory that the optimal transformation pressure is moderate has a close correspondence in industrial economics – the theory of an inverted U. Innovations (or the amount and efficiency of R&D investments) will first increase at stronger competition but then fall at still higher levels of rivalry. As an approximation, innovation vigour will culminate under oligopoly conditions (Cohen and Levin, 1989, p. 1075, Scherer, 1992, pp. 1419-1420).

But an optimal theory of a moderate instead of a maximum transformation pressure can be questioned on both theoretical and empirical grounds. First, a strong pressure is perhaps necessary to get a company to abandon an unfavourable growth trajectory. It is true that it may break those virtuous growth circles emphasised both in the endogenous growth theory, the neo-Schumpeterian theory and the Keynesian growth theory. But a dramatic reduction in current profitability may be required to make it worth to switch to new markets or technologies at high sunk costs. Such fixed costs

---

<sup>14</sup> The historian Arnold Toynbee did also, in fact, advocate a theory of a moderate rather than a maximal pressure (the golden mean) – Toynbee, 1949, ch.VIII. Leibenstein seemed to lean towards a similar conclusion in his writings of the 1980s (Leibenstein, 1980, pp. 94-96, 1984, p. 338).

may be exceptionally high if investment patterns are radically changed. A deep profit crisis may also be needed to break the social-psychological resistance to an adjustment to or development of new product patterns and technological paths (see the section on the psychology of a resistance to change above). A hard transformation pressure may, for instance, break up habitual thoughts in the companies. Habitual learning is an example of habitual thoughts that possibly will reduce not only the incentives but also the abilities to undergo a radical transformation. More knowledge about existing technologies and product markets may lead to locking-in effects by weakening the firms' willingness and capacity to assimilate new technologies and penetrate new markets. The risk of locking-in of productive and financial resources is overlooked in the theories of learning-by-doing and learning-by-using.

Second, the empirical support to the theory of an inverted U is not general. The theory seems only to be valid for industries with limited technological opportunities ("mature" industries) where scale advantages, learning-by-doing and large R&D projects are important (Cohen and Levin, 1989, pp. 1076-1078, Scherer and Ross, 1990, pp. 645-651, Scherer, 1992, pp. 1423-1425, Symeonidis, 1996, pp. 33-34). Empirical studies have even toned down the importance of an inverted U for mature industries (Geroski, 1990, pp. 594-597, 1995, pp. 26-27). In fact, industrial economists emphasise more and more the endogenous character of market-structure conditions. They also focus more and more on technological opportunities and the complementary of small and large firms rather than on the degree of concentration when innovative industries are distinguished. Small firms are said to be more flexible and pioneering while large firms can exploit scale advantages and bear large expenditures in R&D (Acs and Audretsch, 1988, pp. 686-688 and Cohen and Levin, 1989, pp. 1073-1074). Moreover, in dynamic industries, small and large firms are often linked to each other in productive networks.

Thus, it is difficult to generally claim, even for "mature" economies, that a moderate transformation pressure is optimal. The relationship between external pressure and a country's productivity growth depends presumably on branch compositions and industrial networks but also on communications, organisations, competencies, remuneration systems and cultures within firms. For instance, an overvalued currency may be productive but only under some industry and firm specific conditions. The

optimal pressure is also determined by the extent and character of positive external forces. (I assume here that such “opportunities” are not simply the other side of “pressures”.) For example, an overvalued currency may only lead to transformation if research institutes and universities are able to develop the required technologies and products. A depressing conclusion for a puritan macroeconomist is that the optimal transformation pressure varies between countries and from time to time. For instance, an undervalued SEK might have encouraged productivity growth in Swedish industries in the 1930s but not in the 1980s.

The relationship between external challenges and productivity growth is a function of not only the amount but also the composition of individual pressures. Pressure must probably be mild in some dimension to get the highest productivity growth. A pressure in all dimensions may lead to capital flight and an elimination of firms with good prospects. However, the difficulties to formulate a general theory concern not only the extent but also the character of transformation pressure. The composition of external pressure that maximises growth must be determined in each specific case.

## 5.2. The optimal theory of a hard but temporary pressure

The objections to a theory that productivity growth is maximised at a moderate pressure in each period are serious. They justify a discussion of an alternative macroeconomic theory - productivity growth is highest if periods of hard pressure are followed by periods of weak pressure. The industrial structure is trimmed in hard-pressure periods, as low-productive firms will be eliminated, dead-end technological paths abandoned and established companies rationalised. The surviving and new companies must then be offered a period of financial and technical consolidation, scale advantages and escape from pressure to avert immediate threats by one-sided rationalisations. Variations in pressure will lead to a maximal productivity growth if they e.g. form expectations that hard and good times will be lengthy but not last forever.

Few empirical studies have been based on the second modified theory of transformation pressure. In fact, there are only one strong support for a

macroeconomic theory that "catharsises" are the most productive external circumstances as long as they are limited in time - Dahmén's study of Swedish industry in the interwar period. The interwar period is often called the Golden Age of Swedish industry, as production and productivity growth in Sweden was high then in a historical and international perspective (Maddison, 1992, table 3.1-3.3). Productivity growth seems to have been high in Sweden because of a hard transformation pressure in the 1920s and a lesser pressure in the 1930s. In the 1920s, deflationary monetary and exchange-rate policies, primarily in the early decade, resulted, together with fierce international competition (primarily through innovations by foreign firms and trade liberalisation), in a rapid structural change of Swedish manufacturing and a modernisation of leading export sectors. In the 1930s, a restructured manufacturing sector benefited from expansionary monetary policies, depreciations of the SEK, protectionism and inter-industrial diffusions of technologies developed in the preceding decades (Dahmén, 1970, Ch.16, 1998).

A theory that growth is maximised if the transformation pressure is hard, although limited in time, must, as the theory of a moderate pressure, emphasise the decisive role of industry and firm specific conditions and give room for "opportunities" - firms must probably be relieved from pressure in some dimensions or be favoured by positive driving forces other than those that are antipodes to pressure. Dahmén's study indicates that Swedish manufacturing experienced favourable growth conditions in the 1920s through the combination of hard transformation pressure and "opportunities" such as high independent export demand and new knowledge through innovations abroad. However, Sweden's outstanding growth performance in the 1920s cannot be understood without references to industry and firm specific conditions. Swedish companies were fast adapters of new U.S. technologies and organisational models compared to other West European countries. The rapid diffusion of U.S. innovations in Sweden reflected an early outward orientation by Swedish manufacturing explained by the composition and management of leading industrial sectors (Erixon, 1997).

The Swedish experience in the 1920s illustrates also that some shocks may embody both positive and negative driving forces and that productivity be stimulated by both. Innovations by foreign companies put a strong pressure on Swedish companies to be



productive but they also facilitated the spread of new knowledge in Sweden. Productivity growth became high then in Swedish companies through the combined effects of a harder competitive pressure and an enlargement of the pool of knowledge. The reinforcing “opportunity” and “pressure” aspects on a relationship between innovations by other firms (or international trade) and productivity growth are seldom recognised in growth economics (see the introduction).

## 6. The merits of the theory of transformation pressure

A theory that productivity growth is promoted by real external obstacles is largely ignored in growth economics, at least in its macroeconomic version. The theory of transformation pressure can enrich our understanding of historical growth processes and of growth differentials between regions and countries.

It is true that I have stressed the difficulties to formulate an unambiguous theory of transformation pressure. Specification problems shall not hide, however, the scientific and political value of a theory emphasising that macroeconomic conditions matter for productivity growth. The theory builds a bridge between the two isolated islands of macroeconomics – business cycle theory and growth theory. It also builds a bridge between microeconomics, industrial economics and macroeconomics. In fact, the development of the theory of transformation pressure from the late 1980s established a missing bridge span to microeconomics in the Swedish school of industrial economics.

The main contribution of the theory of transformation pressure is not the theory per se but the approach. A distinguish of prime driving forces beyond the control of individual firms and of optimal combinations of positive and negative stimulants offers a fruitful benchmark for studies of industrial processes. For instance, Japanese growth has probably been stimulated by a strong yen, a permanent shortage of raw material markets and, at least in the 1970s and the 1980s, by a growing shortage of (male) labour. Besides, tough domestic competition and qualified home-market demand have shaped the international competitiveness of Japanese firms. But at the same time, high social and cultural entry barriers have favoured Japanese firms, preventing a hard foreign competitive pressure on home markets, at least in a critical

development phase. Japanese industries have also been favoured by the access to new American technologies and by low interest rates through subsidies and a strong yen.

The economic-political relevancy of my theoretical perspective has primarily been illuminated by an analysis of the relationship between exchange-rate conditions and productivity growth. Exchange-rate policies have mostly been seen in mainstream economics as means either to influence aggregate production and employment in the short run or to switch resources between the open and sheltered sector. The relationships between exchange-rate policies on the one hand and the incentives or possibilities of individual firms to raise their productivity on the other hand have only peripherally been accounted for in the economic literature. However, the question whether devaluations or revaluations promote productivity growth can only be answered after a careful study of structural and behaviour conditions in each specific case.

A similar question whether growth is promoted or prevented by large fluctuations in economic activity and profitability can also be raised from my theoretical angle. A criticism that Swedish productivity growth was hampered by large fluctuations in industrial profitability in the 1970s and the 1980s was based on a theory that the optimal pressure is moderate.<sup>15</sup> A general argument that productivity growth will be depressed by exceptionally high and low profits is distinct from that in the theory of investment under uncertainty. In the latter theory, large variations in strategic economic variables are indications of uncertain investment conditions (Hubbard, 1994, pp. 1828-1830). They are not, as in the optimal theory of a moderate transformation pressure, indications of too easy or too hard external circumstances.

The theory of transformation pressure offers a new perspective on the theory of optimal taxation. There are already strong theoretical and empirical arguments in the economic literature against general tax reductions, for instance for R&D investments. General tax cuts, leading to an increase in average profitability, are ineffective as investments are determined by marginal profitability. Moreover, such measures will

---

<sup>15</sup> The profits' share of value added in manufacturing fluctuated more in Sweden than in other OECD countries 1970-1992 with the exception of Belgium and the Netherlands (Erixon, 1994, p. 38, Erixon, 1995). Moreover, the increase in Swedish profit shares since 1992 has been exceptional.

benefit firms that would have invested in any case. The theory of transformation pressure strengthens the arguments against general tax relieves and subsidies - such supports can even curb investments and productivity growth. A possible optimal tax strategy is to raise average company taxes, to get a sharper transformation pressure, but reduce taxes on (or give subsidies to) companies that increase their net investments or employment. The design of the taxation system must prevent, however, that firms will benefit that would have increased their investments and employment without any subsidies (Erixon, 1995).

## 7. Rounding off and suggestions for further research

Productivity growth in manufacturing was lower in Sweden than in competing countries from the mid 1970s to the early 1990s (Erixon, 1991a). Sweden also experienced large losses of market shares, e.g. for R&D-intensive products, in spite of relatively low unit labour costs.<sup>16</sup> A specific theory of transformation pressure was formulated in Sweden in the late 1980s and the early 1990s - unfavourable developments of Swedish markets shares and relative productivity were largely explained by devaluation policies.

From this theoretical angle, the strong recovery in (labour) productivity growth in Swedish manufacturing in the first half of the 1990s was expected.<sup>17</sup> A deep recession, a rise in real interest rates and (initially) a hard currency policy induced Swedish firms to use the large potentials for rationalisations that had been built up in the 1980s and to speed up the introduction of new work organisations. In many firms, rationalisations and organisational changes were integrated processes (Kvarnström, 1995). Furthermore, the elimination of low-productive companies presumably made a significant, although smaller, contribution to the recovery in overall productivity growth in Swedish manufacturing in the 1990s.

---

<sup>16</sup> Erixon, 1989, Edquist, 1991. However, Sweden's losses of market shares and slowness in productivity growth were modest if Japan is excluded from the group of competing countries.

<sup>17</sup> Finland is the only OECD country that had a higher average labour productivity growth in manufacturing than Sweden in the first half of the 1990s.

A theory of a relationship between exchange-rate policies and productivity growth in a country must assume that individual exchange-rate measures will lead to lengthy macroeconomic imbalances or to expectations that similar measures will be used in the future. It must also assume that macroeconomic imbalances may influence the amount and efficiency of those productive activities (e.g. R&D investments) that result in sustainable growth. A country may experience sustainable growth either through cumulative developments within individual firms, if their number is large enough, or through knowledge spillover effects.

A basic idea behind a theory that productivity growth is hampered by devaluations is that firms will only react to challenges that are close at hand or have already occurred. I have presented three separate microeconomic explanations of why productivity growth will first be raised at an obvious external pressure: complete uncertainty, irrationality or the fact that skill formation and creativity will be stimulated by difficulties - necessity is the mother of invention.

However, there are strong theoretical and empirical arguments against an unconditional theory of transformation pressure. Productivity growth is not always stimulated by hard external circumstances. A qualified theory that the optimal external pressure in each period is moderate seems reasonable. A criticism of Swedish economic policies for bolstering a profit boom in the 1980s is still valid. The modified theory of transformation pressure also legitimises a criticism of the large fluctuations in profitability in Sweden from the mid 1970s. A similar criticism may be raised from another theoretical angle – the theory of investment under uncertainty.

The optimal theory of a moderate pressure is probably not even valid for a group of countries with a similar, “mature”, industrial structure. According to a rival theory, the highest productivity growth will be obtained if there are periodical shifts between hard and weak pressures. For instance, firms must be pushed into a more favourable growth path and then be permitted to enjoy the virtuous circles of growth. Thus, the external pressure shall not be watered down by relieves during a certain period but instead be succeeded by periods with a soft pressure. However, the theory must give room for positive driving forces in periods of pressure where competition, demand or

costs are concerned. A similar reference to the need of "opportunities" must be made in the theory of a moderate transformation pressure.

The optimal theory of regular changes in transformation pressure is, in fact, not consistent with the opinion that the pressure became too weak in Sweden in the 1980s. Expansionary economic policies contributing to a profit boom were optimal, as the country had experienced a profitability crisis in the 1970s.

Empirical work on the basis of the theory of transformation pressure has hitherto been preliminary and tentative. But much theoretical work also remains to be done, for instance, to grasp the social-psychological mechanisms behind firms' tendency in good times to postpone a necessary transformation. Here, economists have much to learn from other social sciences. Moreover, the relationship between external pressure and productivity growth must be analysed not only from a firm specific (microeconomic) but also from a structural perspective. A structural analysis can be industry specific (mesoeconomic) or pursued in the macroeconomic dimension of shifts in sectors' share of total production. The structural perspective has been predominant in the Swedish school of industrial economics.

A structural theory of a positive relationship between pressure and productivity growth has already been noticed. The stagnation and exits of firms that have been hit by an external pressure but not succeeded to transform will release resources for the expansion of dynamic firms. But there are many other examples of a relationship between external pressure and productivity growth due to structural changes on the macroeconomic level. External pressures may influence overall productivity growth by their effects on, for instance, the relative size of the exposed, R&D-intensive and capital-intensive sectors and the relative importance of new firms (Erixon, 1991b, pp. 294-302). New firms are not particularly favoured by devaluations as they, in general, are not exposed for foreign competition or able to exploit new market opportunities created by (net-) export demand multipliers (as entry barriers often prevent the formation of new firms.) On the contrary, they are disfavoured by higher interest rates and nominal wages (and by higher input prices in general) and the fact that risk capital will be kept in or allocated to established firms in the aftermath of their expansion (cf. Svernilson, 1954, pp. 24, 34-36, 49-50). A country's productivity

growth will decrease after a devaluation, *ceteris paribus*, if new firms' share of total production is reduced and their productivity growth or productivity levels are higher than those of established firms.

A central object of future research is to formulate the theory of transformation pressure in structural terms. The theory must be based on a macroeconomic notion of transformation unlike that in my paper. A complete picture of the mechanisms behind a relationship between external pressure and productivity can only be achieved by an integrated analysis of firm behaviour and structural changes.

## References

Acs, Zoltan, Audretsch, David B, 1988. Innovation in large and small firms: an empirical analysis. *American Economic Review* 78 (4), 678-690.

Aghion, Philippe, Howitt, Peter, 1992. A model of growth through creative destruction. *Econometrica* 60(2), 323-351.

Aghion, Philippe, Harris, Christopher, Vickers, John, 1997. Competition and growth with step-by-step innovation: an example. *European Economic Review* vol 41(4), 771-782.

Baily, Martin, Gersbach, Hans, 1995. Efficiency in manufacturing and the need for global competition. *Brookings Papers on Economic Activity*, Brookings Institution, Washington D.C., 307-347.

Barro, Robert, Sala-i-Martin, Xavier, 1995. *Economic Growth*. McGraw-Hill, Inc., New York.

Cohen, Wesley, Levin, Richard, 1989. Empirical studies of innovation and market structure. In: Schmalensee, Richard, Willig, Robert (Eds.), *Handbook of Industrial Organization* Vol. II, North-Holland, Amsterdam.

Dahmén, Erik, 1970. Entrepreneurial Activity and the Development of Swedish Industry 1919-1939. Richard D. Irwin Inc., Hoewood, Illinois. First published in Swedish in 1950.

Dahmén, Erik 1998. Technology, technique, and, entrepreneurial activity in economic theory - and historical outline. In: Swedish Council for Planning and Coordination of Research (Ed.), Technological Systemic Changes and Economic Theories, FRN report 1998:5, Stockholm.

De Alessi, Louis, 1983. Property rights, transaction costs, and x-efficiency: an essay in economic theory. *The American Economic Review* 73(1), 64-81.

Davis, James, Kameda, Tatsuya, Stasson, Mark, 1992. Group risk taking: selected topics. In: Yates, J.F. (Ed.), *Risk-Taking Behaviour*, Ch.6, 163-199.

Dixit, Avinash, Pindyck, Robert, 1994. *Investment Under Uncertainty*. Princeton University Press, Princeton.

Edquist, Charles, 1991. Högteknologiska produkter och produktivitet i svensk industri. In: Produktivitetsdelegationen, *Forskning, teknikspridning och produktivitet*, expert report no 10, Allmänna Förlaget, Stockholm.

Eiser, J, Pligt, J. Van Der, 1988. *Attitudes and Decisions*. New Essential Psychology, Routledge, London.

Erixon, Lennart, 1989. Den tredje vägen – inlåsning eller förnyelse?. *Ekonomisk Debatt* 17(3), 181-195.

Erixon, Lennart, 1991a. Styrfel - inte systemfel - orsak till Sveriges eftersläpning?. *Ekonomisk Debatt* 19(1), 47-52.

Erixon, Lennart, 1991b. Omvandlingstryck och produktivitet. In: Produktivitetsdelegationen, *Konkurrens, regleringar och produktivitet*, expert report no 7, Allmänna Förlaget, Stockholm.

Erixon, Lennart, 1994. Investeringar och lönsamhet - Svensk kapitalbildning i historisk och komparativ belysning. Appendix 7 to Långtidsutredningen, Finansdepartementet, Fritzes, Stockholm.

Erixon, Lennart, 1995. Begreppet omvandlingstryck – en ny infallsvinkel på ekonomisk politik. Ekonomisk Debatt 23(5), 385-397.

Erixon, Lennart, 1997. The Golden Age of the Swedish Model - The Coherence Between Capital Accumulation and Economic Policy in Sweden in the Early Postwar Period. Institutt for Samfunnsforskning, Report 97:9, Oslo.

Frantz, Roger, 1992. X-efficiency and allocative efficiency: what have we learned?. The American Economic Review 82(2), 434-438.

Geroski, P. A., 1990. Innovation, technological opportunity and market structure. Oxford Economic Papers 42(3), 586-602.

Geroski, P.A., 1995. Innovation and Competitive Advantage. OECD Economics Department, Working Papers no. 159, Paris.

Greenwald, Bruce, Stiglitz, Joseph, 1993. New and old Keynesians. Journal of Economic Perspectives 7(1), 23-44.

Grossman, Gene, Helpman Elhanan, 1991. Innovation and Growth in the Global Economy. The MIT Press, Cambridge, Massachusetts.

Grossman, Gene, Helpman, Elhanan, 1994. Endogenous innovation in the theory of growth. The Journal of Economic Perspectives 8(1), 23-44.

Harcourt, G.C., Kenyon, Peter, 1976. Pricing and the investment decision. KYKLOS 29(3), 449-477.



Harrod, Roy, 1970. Dynamic theory. In Growth Economics, Amartya Sen (editor), Penguin Economic Readings, Middlesex (England). First published in 1939.

Hermalin, B. E., 1992. The effects of competition on executive behavior. RAND Journal of Economics 23(3), 350-365.

Horn, Henrik, Lang, Harald, Lundgren, Stefan, 1995. Managerial effort incentives, x-inefficiency and international trade. European Economic Review 39(1), 117-138.

Hubbard, Glenn, 1994. Investment under uncertainty: keeping one's options open. Journal of Economic Literature 32(4), 1816-1831.

Ingenjörsvetenskapsakademien, 1991. "Bäst i världen" – vad kan vi lära av världens Produktivitetsdelegationen, expert report nr 6, Allmänna Förlaget, Stockholm.

Kalecki, Michal, 1965. Theory of Economic Dynamics - An Essay on Cyclical and Long-Run Changes in Capitalist Economy. Modern Reader Paperbacks, New York and London. First published in 1954.

Kahneman, Daniel, Tversky, Amos, 1979. Prospect theory: an analysis of decision under risk. Econometrica 47(2), 263-291.

Kahneman, Daniel, Tversky, Amos, 1987. Rational choice and the framing of decisions. In: Hogarth, Robin, Reder, Melvin (eds.), Rational Choice - The Contrast Between Economics and Psychology, The University of Chicago Press, Chicago and London, 67-94.

Kvarnström, Christina, 1995. Produktivitetssprånget - vad har en förändrad arbetsorganisation betytt? NUTEK Analys, Stockholm.

Leibenstein, Harvey, 1979. A branch of economics is missing: micro-micro theory. Journal of Economic Literature 17(2), 477-502.

Leibenstein, Harvey, 1980. *Beyond Economic Man - A New Foundation for Microeconomics*. Harvard University Press, Cambridge Massachusetts.

Leibenstein, Harvey, 1984. The Japanese management system: an x-efficiency-game theory analysis. In: Aoki, Masahiko (ed.), *The Economic Analysis of the Japanese Firm*, North-Holland, New York.

Lindbeck, Assar, 1993. *Unemployment and Macroeconomics*. The MIT Press, Cambridge, Massachusetts.

Maddison, Angus, 1992. *Dynamic Forces in Capitalist Development – A Long-Run Comparative View*. Oxford University Press, Oxford.

Mann, Leon, 1992. Stress, affect, and risk taking. In: Yates, J.F. (ed.), *Risk-Taking Behavior*, Ch.7, 201-230.

Nelson, Richard, 1981. Research on productivity growth and productivity differences: dead ends and new departures. *Journal of Economic Literature* 19(3), 1020-1064.

Nickell, Stephen, Nicolitsas, Daphne, Dryden, Neil, 1997. What makes firms perform well? *European Economic Review* 41(4), 783-796.

Porter, Michael, 1990. *The Competitive Advantage of Nations*. The MacMillan Press, London.

Produktivitetsdelegationen, 1992. *Forces of Productivity and Prosperity*. Summary of SOU 1991:92, Allmänna Förlaget, Stockholm.

Rivera-Batiz, Luis, Romer, Paul, 1991. Economic integration and endogenous growth. *Quarterly Journal of Economics* 106(2), 531-555.

Romer, Paul, 1990. Endogenous technological change. *Journal of Political Economy* 98(5), 71-102.

Salter, Wilfred, 1960. *Productivity and Technical Change*. Cambridge University Press, Cambridge.

Scitovsky, Tibor. 1943. A note of profit maximisation and its implications. *Review of Economic Studies* 11(1), 57-60.

Scherer, F.M., 1984. *Innovation and Growth – Schumpeterian Perspectives*. Cambridge Massachussets.

Scherer, F.M., 1992. Schumpeter and plausible capitalism. *Journal of Economic Literature* 30(3), 1416-1433.

Scherer, F.M., Ross, D., 1990. *Industrial Market Structure and Economic Performance*. Third Edition, Houghton Mifflin Company, Boston.

Schmookler, Jacob, 1966. *Invention and Economic Growth*. Harvard University Press, Cambridge, Massachusetts.

Schmookler, Jacob, 1972. *Patents, Invention, and Economic Change – Data and Selected Essays*. Zvi Griliches, Zvi, Hurwics, Leonid (eds.), Harvard University Press, Cambridge Massachusetts.

Schön, Lennart, 1990. *Electricitetens betydelse för svensk industriell utveckling*. Vattenfall, Vällingby.

Simon, Herbert A., 1978. Rationality as process and as product of thought. *American Economic Review* 68(2), 1-16.

Solow, Robert, 1956. A contribution to the theory of economic growth. *Quarterly Journal of Economics* 70(1), 65-94.

Solow, Robert, 1964. *Capital Theory and the Rate of Return*. North-Holland Publishing Company, Amsterdam.

Steindl, Josef, 1979. Stagnation theory and stagnation policy. *Cambridge Journal of Economics* 3(1), 1-14.

Svennilson, Ingvar, 1954. *Growth and Stagnation in the European Economy*. United Nations Economic Commission for Europe, Geneva.

Symeonidis, George, 1996. *Innovation, Firm Size and Market Structure: Schumpeterian Hypotheses and Some New Themes*. OECD Economics Department, Working Papers no. 161, Paris.

Toynbee, Arnold, 1949. *A Study of History*. Abridgement of volumes I-VI by D.C. Somervell, Oxford University Press, London.

Utterback, James (1994). *Mastering the Dynamics of Innovation - How Companies Can Seize Opportunities in the Face of Technological Change*. Harvard Business School Press, Boston, Massachusetts.

Yates, Frank J. (ed.), 1992. *Risk-Taking Behavior*. Wiley Series in Human Performance and Cognition, John Wiley & Sons, New York.

Åkerman, Johan, 1960. *The Theory of Industrialisation - Causal Analysis and Economic Plans*. Gleerups Förlag, Lund.